

# TRILOBITES FROM THE ALBANY DIVISION (ORDOVICIAN) OF THE GIRVAN DISTRICT, AYRSHIRE

by RONALD PEARSON TRIPP

ABSTRACT. Two new genera, and nine new species of trilobites from the Albany mudstones with nodular limestones, east of Doularg, near Girvan, are described. The fauna is most closely allied to that of the *superstes* Mudstones, Aldons, having twenty-two of twenty-five genera in common, and fourteen species closely related. Outside the district the closest resemblance is to the lower Edinburg Formation (Porterfield Stage) of the Appalachian Valley of the U.S.A.

THE trilobites are from the Albany mudstones with nodular limestones, exposed in a stream section, 950 yards east-north-east of Doularg Farm, Stinchar Valley, Girvan (Nat. Grid Ref. NX 269929). Correlation with the mixed shelly-graptolitic facies of the Lower Barr Series indicates that the fossiliferous member of the Albany mudstones is basal Caradoc (within the *Nemagraptus gracilis* zone): but the trilobite fauna *per se* is best compared with those typical of the Porterfield Stage of the standard Ordovician for NE. America. The exposure was discovered by Professor Alwyn Williams in the course of his field work in the district, and has been described by him (Williams 1962, pp. 45-47). I am greatly indebted to Professor Alwyn Williams for showing me the locality. Sincere thanks are also due to Dr. John Temple and Professor H. B. Whittington for help in the preparation of this paper.

The terminology is essentially that adopted in the Treatise on Invertebrate Paleontology, Part O. Almost all the specimens are preserved as internal and external moulds. All the specimens were collected by the author; the type and figured specimens have been presented to the Hunterian Museum, Glasgow University.

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## SYSTEMATIC DESCRIPTIONS

## Family GERAGNOSTIDAE Howell 1935

## Genus TRINODUS M'Coy 1846

*Trinodus doulargensis* sp. nov.

Plate 80, figs. 1-4

*Diagnosis.* Convexity moderately strong. Glabella two-thirds length of cephalon, parallel sided for most of its length; glabellar tubercle and furrows lacking. Posterior borders produced backwards into short spines. Surface smooth.

*Holotype.* A. 5830a, b (cephalon). Plate 80, figs. 1a, b.

*Other material.* One cephalon, one thoracic segment, three pygidia.

*Dimensions of holotype* (in mm.).

Length of cephalon . . . . .	2.2
Maximum width of cephalon (est.) . . . . .	2.1
Length of glabella . . . . .	1.5
Maximum width of glabella . . . . .	0.9

*Description.* Cephalon narrowly rounded, as wide as long. Glabella parallel sided for most of its length, two-thirds length of cephalon, moderately convex; glabellar tubercle and furrows lacking. Basal lobes small, triangular, not touching mesially. Axial and preglabellar furrows deep and broad. Cheeks convex, uniformly narrow. Border moderately wide and convex, narrowing out towards back. Border furrow well defined. Posterior borders swollen, produced backwards into short triangular genal spines. Surface smooth.

Thoracic segment with axis occupying three-quarters total width. Median lobe twice as wide posteriorly as anteriorly. Oval lateral lobes approximately one-third width of axis, their long axes inclined inwards and forwards, strongly demarcated. Axial furrows deep and broad. Pleurae narrow (tr.), longitudinally truncate, weakly swollen; anterior and posterior lobes scarcely developed.

Pygidium subquadrate. Articulating half-ring and pleural facets well developed. Axis slightly less than half length of pygidium. First ring short, with small, oval lateral lobes. Second ring long; elongate median lobe rising steeply towards back to form a rounded node. Terminal piece about one-third length of axis. Axial furrows deep and broad. Pleural lobes convex, narrowing towards front. Border weakly convex, extremely wide posteriorly particularly opposite the pair of small lateral spines. Border furrow well defined. Surface smooth.

*Remarks.* *T. doulargensis* bears a close resemblance to *T. elspethi* (Raymond) (see Cooper 1953, pp. 7-8, pl. 1, figs. 1-12) from the Edinburg Formation, in all parts. The glabella is more parallel sided and lacks the median tubercle, the pygidium has a broader axis and border, and the dorsal exoskeleton is smooth, not granular.

*Trinodus* sp.

Plate 80, figs. 5-7

*Material.* Two cephalata, two pygidia.

*Description.* Glabella moderately long, narrowing slowly forwards; glabellar tubercle and furrows lacking. Basal lobes small, sloping steeply backwards. Axial and preglabellar furrows moderately deep. Border narrows out towards back. Posterior borders strongly swollen, widening (exs.) laterally, not produced backwards as spines. Surface smooth.

Axis slightly less than half length of pygidium, strongly swollen. Two rings, subequal in length, occupy slightly more than half length of axis. First ring with large, well-defined lateral lobes. Elongate median tubercle on second ring rises towards back. Axial furrows moderately deep. Pleural lobes of uniform width. Border wide posteriorly. A pair of oblique ridges cross border at postero-lateral angles, produced into short, broad-based spines. Surface smooth.

*Remarks.* The cranium figured lacks glabellar tubercles and furrows and appears to be referable to *Trinodus*; it differs from the foregoing species in the shape of the glabella and absence of fixigenal spines. The long axis of the pygidium suggests reference to *Geragnostus* rather than *Trinodus*. However, it may be closely compared with *Trinodus* sp. from the Ashgillian of Poland (Kielan 1959, p. 62, pl. 1, fig. 5, text-fig. 14).

Family KOMASPIDIDAE Kobayashi 1935

Genus CARRICKIA gen. nov.

*Diagnosis.* Glabella subquadrate, weakly convex; lateral glabellar furrows absent. Preglabellar field short. Anterior border wide (tr.). Palpebral lobes narrow, depressed, two-thirds length of glabella, reaching almost to back of cheeks.

*Type species.* *Carrickia pelagia* sp. nov.

*Remarks.* So far as is known the genus is monotypic. The genus is referred to the Family Komaspidae on account of the long palpebral lobes, wide fixed cheeks, and short preglabellar field. Both cranium and pygidium bear a general resemblance to *Gonio-phrys prima* Ross (1951, pp. 81-82, pl. 18, figs. 9, 15, 17-20, 22, 27) from the Garden City Formation, but the new form differs conspicuously in the broader, less convex, glabella, and transversely wider anterior border. In the aforementioned features, *Carrickia* bears a resemblance to the dimeropygid *Chomatopyge* Whittington and Evitt (1954, pp. 49-53)

from the Lincolnshire and Edinburg Limestones, but the length of the palpebral lobes, short preglabellar field, absence of median preglabellar pit, and the conspicuously distinctive pygidium preclude affiliation with this genus.

*Carrickia pelagia* gen. et sp. nov.

Plate 81, figs. 17-21

*Diagnosis.* As for genus.

*Holotype.* A. 5878 (cranium). Plate 81, figs. 17a-c.

*Paratype.* A. 5882 (pygidium).

*Other material.* Fourteen cranidia, nine pygidia.

*Material from other horizons.* Cranidia from the platy upper Stinchar Limestone, and from the *superstes* Mudstones, Aldons.

<i>Dimensions</i> (in mm.).	<i>Holotype</i>	<i>A. 5880</i>
Length of cranium (sag.)	3.4	2.3
Length of glabella	2.4	1.7
Width of glabella	3.2	2.0

EXPLANATION OF PLATE 80

All the figured specimens are from the Albany mudstones with nodular limestones, 950 yards east-north-east of Doularg Farm, Stinchar Valley, Girvan; they have been deposited in the Hunterian Museum, Glasgow. The photographs are of internal moulds unless otherwise stated; the specimens were coated with ammonium chloride before being photographed.

Figs. 1-4. *Trinodus doulargensis* sp. nov. 1a, b, Cephalon (holotype A. 5830b). Latex cast from external mould. Dorsal and oblique lateral views,  $\times 10$ . 2, Thoracic segment (A. 5831). Latex cast from external mould,  $\times 10$ . 3, Pygidium (A. 5832). Latex cast from external mould,  $\times 8$ . 4, Pygidium (A. 5833b). External mould,  $\times 8$ .

Figs. 5-7. *Trinodus* sp. 5, Cranium (A. 5834b). External mould,  $\times 8$ . 6, Pygidium (A. 5835a),  $\times 10$ . 7, Pygidium (A. 5836b). External mould,  $\times 10$ .

Figs. 8, 9, 17. *Remopleurides* sp. A. 8, Left free cheek (A. 5837). Lateral view showing doublure,  $\times 4$ . 9, Right free cheek (A. 5838a), showing vincular ledge and ridge on doublure,  $\times 4$ . 17, Hypostome (A. 5839b). External mould,  $\times 8$ .

Figs. 10, 11. *Remopleurides* sp. B. 10, Left free cheek (A. 5840)  $\times 5$ . 11, Right free cheek (A. 5841). External mould showing raised lines,  $\times 10$ .

Figs. 12-15. *Remopleurides* sp. C. 12, Small cranium (A. 5842),  $\times 8$ . 13, Right free cheek (A. 5843),  $\times 6$ . 14, Hypostome (A. 5844),  $\times 8$ . 15, Pygidium (A. 5845),  $\times 8$ .

Fig. 16. *Hypodiceranotus* sp. Left free cheek (A. 5846b). Latex cast from external mould,  $\times 8$ .

Figs. 18, 19. *Isotelus* sp. 18, Cranium (A. 5847). Oblique lateral view, showing elevated palpebral lobe,  $\times 1$ . 19, Pygidium (A. 5848), with doublure exposed,  $\times 1$ .

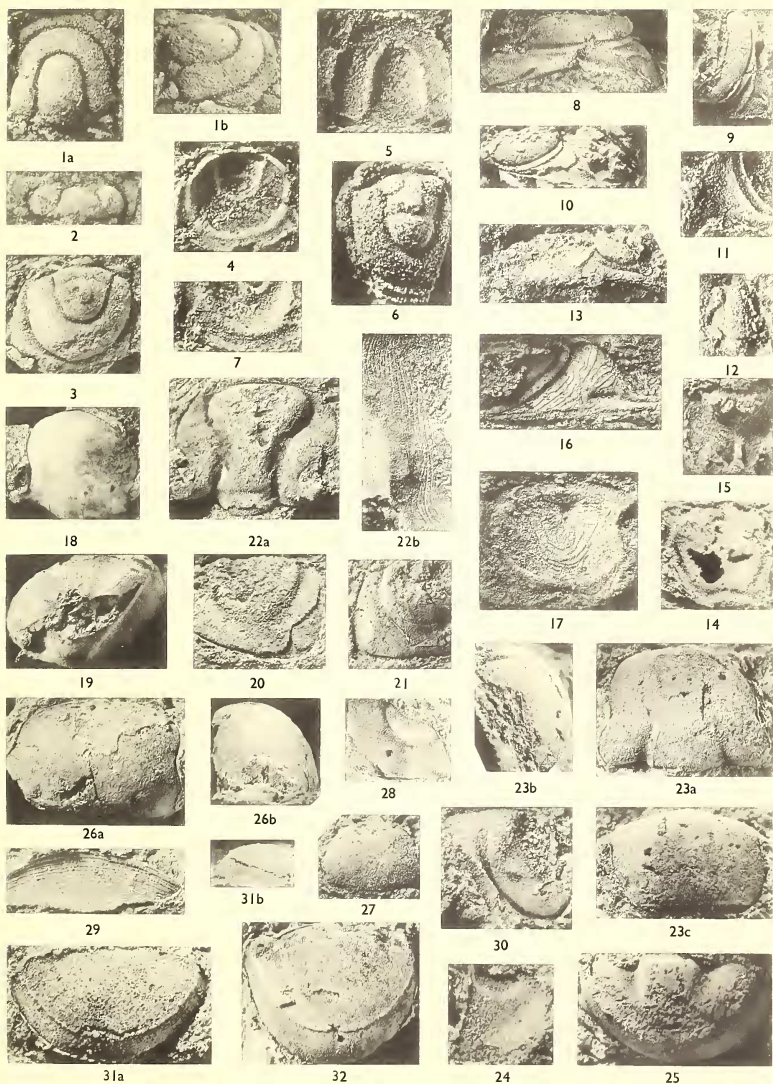
Figs. 20, 21. *Nileus* sp. 20, Left free cheek (A. 5849),  $\times 5$ . 21, Left free cheek (5850a) belonging to an individual with a shorter cephalon,  $\times 5$ .

Figs. 22a, b. *Raymondaspis* sp. 22a, Cranium (A. 5851a),  $\times 4$ . 22b, The same, external mould (A. 5851b), showing raised lines on glabella, and right basal lateral furrows,  $\times 8$ .

Figs. 23-25. *Illaeus* sp. 23a-c, Cranium (A. 5852a). Dorsal, lateral, and frontal views,  $\times 4$ . 24, Left free cheek (A. 5853). External mould,  $\times 10$ . 25, Pygidium (A. 5854a),  $\times 5$ .

Figs. 26-32. *Bumastoides scoticus* sp. nov. 26a, b, Cranium (A. 5855a). Dorsal and lateral views,  $\times 3$ . 27, Small cranium (A. 5856),  $\times 6$ . 28, Right free cheek (A. 5857),  $\times 6$ . 29, Rostral plate (A. 5858b). External mould,  $\times 5$ . 30, Hypostome (A. 5859), probably belonging to this species. External mould. Oblique lateral view showing left anterior wing with longitudinal raised lines,  $\times 10$ . 31a, Pygidium (holotype, A. 5860a). Dorsal view,  $\times 7$ . 31b, The same. Lateral view,  $\times 5$ . 32, Elongate pygidium (A. 5861a),  $\times 4$ .







*Description.* Cranium broadly rounded anteriorly, moderately convex in both directions. Glabella subquadrate, broadly rounded anteriorly, moderately convex. Lateral glabellar lobes and furrows absent. Occipital ring little longer mesially than laterally. Occipital furrow transverse but sinuous, deep, narrower than axial furrows. Preglabellar and axial furrows continuous, moderately deep and narrow. Preglabellar field short laterally, usually narrowing out mesially, weakly convex, continuous with fixed cheeks. Anterior border much wider (tr.) than glabella, of uniform length, rolled. Anterior border furrow broad. Fixed cheeks gentle convex, widening steadily towards back, sloping away from glabella. Palpebral lobes narrow, depressed, weakly rounded in outline, two-thirds length of glabella, reaching almost to back of fixed cheeks, posterior extremities much further apart than anterior extremities. Palpebral furrows broad, with outer wall lower than inner. Posterior borders convex, expanding little laterally. Posterior border furrows deep and broad, widening laterally. Anterior branches of facial sutures curve forwards and slightly inwards; posterior branches short, directed backwards and outwards. Surface smooth; glabella, occipital ring, and inner areas of fixed cheeks shallowly pitted.

Pygidium elliptical in outline, strongly convex in both directions. Axis occupies more than half anterior width, transverse curvature slightly greater than that of pygidium, broad and undefined posteriorly; articulating half ring and two rings well defined, bowed backwards, terminal piece with strong independent convexity. Axial furrows sharp, bowed outwards alongside rings and terminal piece, flaring posteriorly and dying out before reaching margin. Two pairs of pleurae; interpleural furrows sharp, extending to margin; pleural furrows oblique, deep. Surface finely granular.

*Remarks.* The diagnostic characters of the genus clearly distinguish this form. The pygidia described are attributed to this species mainly on the grounds of comparable frequency, but they are appropriate to the family.

Family REMOPLEURIDIDAE Hawle and Corda 1847

Genus REMOPLEURIDES Portlock 1843

*Remopleurides* sp. A

Plate 80, figs. 8, 9, 17

*Material.* Eight free cheeks, three hypostomes.

*Remarks.* These free cheeks and hypostomes closely resemble a form which occurs in the *confinis* Flags (Tripp 1962, pp. 4-5, pl. 1, figs. 10-14), the Stinchar Limestone, and the *superstes* Mudstones. The free cheeks differ in lacking the posterior border furrow, in their non-striate surface, and in the presence of an oblique ridge on the doublure, tangential to the vincular ledge which is situated further back (Pl. 80, fig. 9). The hypostome is narrower posteriorly, and the anterior boss is more prominent.

*Remopleurides* sp. B.

Plate 80, figs. 10, 11

*Material.* Two free cheeks, one pygidium.

*Description.* Free cheek moderately wide posteriorly; librigenal spine straight, slender,

moderately long; subgenal notch extends half-way across border. Surface with moderately spaced raised lines.

Pygidium elongate, with axis defined only by independent convexity. Pleurae fused except for two pairs of free points on posterior margin, outer pair extending slightly further backwards than inner pair.

*Remarks.* An allied species occurs in the *superstes* Mudstones, Aldons. The affinities of these two forms are with *R. caelatus* Whittington (1959, pp. 401-11, pls. 1-3; pl. 4, figs. 1-25; text-figs. 4, 5) from the Edinburg Formation, and with *R. plaesiourus* Whittington (1959, pp. 412-14, pl. 4, figs. 26-30; pl. 5; pl. 6, figs. 1-15) from the Lower Martinsburg shale, both from northern Virginia.

### *Remopleurides* sp. C

Plate 80, figs. 12-15

*Material.* One cranium, two free cheeks, two hypostomes, one pygidium.

*Description.* One small, incomplete cranium; glabella abruptly expanded, weakly convex; anterior tongue long, moderately wide, almost horizontally extended. Occipital ring long and narrow. Palpebral lobes broad (tr.). Surface apparently smooth.

Eye short, broad, and strongly convex transversely, weakly rounded in outline. External rim of eye lobe broad and weakly rounded, depressed anteriorly where marked off by broad furrows, dying out posteriorly. Border convex anteriorly, with a steep, salient anterior extension. Border widens and merges with eye rim posteriorly, produced into a strong, straight, broad based, librigenal spine.

Hypostome elongatedly trapeziform in outline, almost as long as wide. Middle body convex, well defined. Anterior boss not prominent. Lateral and posterior borders narrow; postero-lateral forks absent.

Pygidium subquadrate. Axis swollen, composed of two segments. Anterior pleurae narrowly pointed, extending backward as far as second pair. Space between inner pair of pleurae long and narrow. Doublure broad, curling upwards along inner margin.

*Remarks.* The short eye is a commanding feature in both cranium and free cheek. All the parts described may not belong to one species.

### Genus HYPODICRANOTUS Whittington 1952

#### *Hypodicranotus* sp.

Plate 80, fig. 16

*Material.* One free cheek.

*Description.* Free cheek narrow anteriorly, lateral outline almost straight. External rim of eye lobe marked off by sharp furrows. Cheek weakly convex. Lateral and posterior border furrows lacking. Genal angle acute. Subgenal spine narrow, directed almost straight backwards, extending a short way beyond posterior margin. Subgenal notch narrow, tapering slowly, more than half length of subgenal spine. Surface of posterior area and subgenal spine with faint, anastomosing, subconcentric terrace lines, widely spaced.

*Remarks.* The discovery of a *Hypodicranotus* type of hypostome in the upper platy Stinchar Limestone, Auchensoul Hill, establishes the occurrence of the genus in the Girvan District at a considerably earlier date than any of the North American records. The single free cheek from the Albany Mudstones differs from both *H. striatulus* (Walcott) (see Whittington 1952, pl. 1, figs. 1-6, 8, 10) and from *H. missouriensis* (Foerste) (see Bradley 1930, p. 30, figs. 6-8) mainly in the shorter (exs.) subgenal notch, more slender subgenal spines, and the presence of terrace lines on the posterior area.

Family ASAPHIDAE Burmeister 1843

Genus ISOTELUS DeKay 1824

*Isotelus* sp.

Plate 80, figs. 18, 19

*Material.* Two cranidia, two free cheeks, three pygidia.

*Description.* Cranium narrow, gently convex in both directions. Glabella ill defined, weakly expanded anteriorly. Palpebral lobes placed far back, strongly elevated, with cheeks drawn up at base. Axial furrows faint.

[Free cheek with elevated eye. Vincular notches weakly developed. Surface pitted.]

[Pygidium subtriangular, gently convex in both directions, unsegmented. Axis broad at front, faintly defined by broad depressions anteriorly. Anterior half pleurae swollen, marked off by broad depressions; articulating facets strong. Doublure broad; inner area broad and gently concave at apex, narrowing and becoming convexly upturned anterolaterally. Terrace lines well marked.]

*Remarks.* The elevated eye lobes are a peculiar feature of this species.

Family NILEIDAE Angelin 1854

Genus NILEUS Dalman 1827

*Nileus* sp.

Plate 80, figs. 20, 21

*Material.* One cranium, five free cheeks.

*Material from other horizons.* All parts from the *superstes* Mudstones, Aldons.

*Remarks.* The genus *Nileus* has not been previously recorded from the Girvan District. The long eyes are one of the diagnostic characters of this species which will be fully described on material from Aldons in a subsequent paper.

Family SCUTELLUIDAE Richter and Richter 1955

Genus RAYMONDASPIS Příbyl 1949

*Raymondaspis* sp.

Plate 80, figs. 22a, b

1931 *Bronteopsis* cf. *nitens* (Wiman) Reed, pp. 26-27.

*Material.* One cranium, one hypostome.

*Material from other horizons.* All parts common in the *superstes* Mudstones, Aldons.

*Remarks.* The well-marked basal lateral glabellar furrows and the raised lines on the cranium occur also in *R. brumleyi* (Cooper 1953, p. 25, pl. 9, figs. 8–10) but are lacking in *R. nitens* (Wiman) (see Skjeseth 1955, p. 22, pl. 4, figs. 1, 3); the closer affinity appears to be with the former species.

Family ILLAENIDAE Hawle and Corda 1847

Genus ILLAENUS Dalman 1824

*Illaeus* sp.

Plate 80, figs. 23–25

*Material.* Five cranidia, one free cheek, four pygidia.

*Description.* Cranidia strongly convex longitudinally. Glabella wide, short. Axial furrows shallow, bowed strongly inwards. Cheeks with slight independent convexity. Palpebral lobes long, placed far back, weakly rounded in outline. Surface smooth except for a median tubercle near base of glabella.

Free cheek wide, gently convex. Lateral margin rounded, basal angle acute, but not produced into a spine.

Pygidium moderately convex in both directions, broadly rounded in outline. Axis short, gently swollen, more than one-third anterior width, projecting anteriorly, defined by broad, shallow furrows. Doublure short, monocuspid.

*Remarks.* There is a similarity between this species and *I. devexus* Tripp (1962, p. 12, pl. 2, figs. 10a, b) in convexity, and in the proportions of the glabella, but the cranium is shorter in the Doularg form, and the glabella does not widen anterior to the eyes.

EXPLANATION OF PLATE 81

Figs. 1–3. *Hibbertia whittingtoni* sp. nov. 1a–c, Cephalon without upper lamella (holotype, A. 5862a).

Dorsal, frontal, and lateral views,  $\times 6$ . 2, Cephalon (A. 5863a),  $\times 4.5$ . 3, Fragmentary cephalon (A. 5864). External mould, showing pits on glabella,  $\times 15$ .

Figs. 4–10. *Dimeropyge hystrix* sp. nov. 4a, Cranium (holotype, A. 5865a). Dorsal view,  $\times 6$ .

4b, c, The same. Anterior and lateral views,  $\times 8$ . 5, Cranium (A. 5866), with uniformly tuberculate occipital ring,  $\times 6$ . 6, Cranium (A. 5867a), with a pair of exceptionally large swellings at inner extremities of posterior borders,  $\times 8$ . 7, Cranium (A. 5868b). Latex cast from external mould, showing three aciculate tubercles at back of occipital ring, a pair of prominent tubercles on pre-glabellar field, and aciculate tubercle at left anterior margin of anterior border,  $\times 10$ . 8, Left free cheek (A. 5869). External mould, showing aciculate tubercles on margin,  $\times 8$ . 9, Right free cheek (A. 5870), showing vincular swelling on doublure,  $\times 6$ . 10, Pygidium (A. 5871a). Oblique posterior view,  $\times 10$ .

Figs. 11a, b. *Toernquistia* sp. A. Cranium (A. 5872). Dorsal and frontal views,  $\times 14$ .

Fig. 12. *Toernquistia* sp. B. Cranium (A. 5873a),  $\times 8$ .

Figs. 13, 14. *Mesotaphraspis* sp. 13a, b, Cranium (A. 5874). Dorsal and lateral views,  $\times 12$ . 14, Right free cheek (A. 5875a), possibly belonging to this form,  $\times 12$ .

Fig. 15. Unassigned free cheek (A. 5876),  $\times 6$ .

Fig. 16. Unassigned hypostome (A. 5877a),  $\times 8$ .

Figs. 17–21. *Carrickia pelagia* gen. et sp. nov. 17a–c, Cranium (holotype, A. 5878). Dorsal, frontal, and lateral views,  $\times 8$ . 18, Cranium (A. 5879b). External mould, showing pits on glabella and inner part of fixed cheek,  $\times 12$ . 19, Cranium (A. 5880),  $\times 7$ . 20, Small cranium (A. 5881b), with narrow glabella. External mould showing smooth surface,  $\times 12$ . 21a, b, Pygidium (A. 5882). Dorsal and posterior views,  $\times 18$ .

Figs. 22, 23. *Ampyx* sp. 22, Cranium (A. 5883). Oblique lateral view,  $\times 3$ . 23, Pygidium (A. 5884a) attributed to this species,  $\times 4$ .





1a



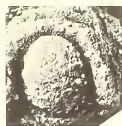
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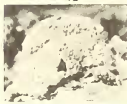
4a



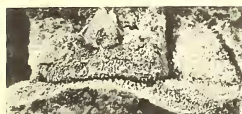
4b



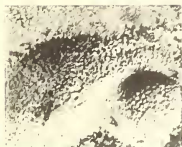
5



4c



1b



3



7



6



1c



15



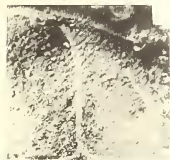
9



8



17a



18



14



10



13b



17b



19



11b



13a



16



17c



20



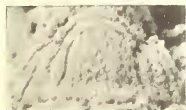
11a



22



21a



21b



12



23



## Genus BUMASTOIDES Whittington 1954

*Bumastoides scoticus* sp. nov.

Plate 80, figs. 26-32

*Diagnosis.* Cranidium subquadrate, strongly convex longitudinally, weakly so transversely. Palpebral lobes weakly rounded, forwardly placed. Anterior margin of pygidium almost transverse; doublure short, with a minute median cusp.

*Holotype.* A. 5860a, b (pygidium) Plate 80, figs. 31a, b.

*Paratypes.* A. 5855a, b (cranidium); A. 5857 (free cheek).

*Other material.* Twelve cranidia, seven free cheeks, two rostral plates, one hypostome, thirty-seven pygidia.

*Dimensions* (in mm.).

	<i>Holotype</i>	<i>A. 5861a, b</i>
Length of pygidium . . .	3.1	6.7
Width of pygidium . . .	5.3	8.3

*Description.* Cranidium subquadrate, strongly convex longitudinally particularly near back, weakly so transversely. Lunate muscle impressions shallow, situated near back of cranidium and four-sevenths of cranial width apart. Shallow apodemes on posterior margin, slightly wider apart. Palpebral lobes weakly rounded, forwardly placed. Anterior branches of facial sutures run almost straight forwards at first, bending inwards anteriorly; posterior branches run backwards and slightly outwards. Surface smooth; one or two terrace lines run parallel to anterior margin and curve round parallel to facial sutures.

Free cheek weakly convex. Eye large, seven-tenths of its own length from posterior margin, situated at about the same distance from lateral as from posterior margin; lens surface convex, marked off by a shallow depression. Posterior and lateral margins almost straight; genal angle broadly rounded. Doublure lies close to dorsal surface posteriorly, increasingly convex anteriorly.

Rostral plate broadly rounded anteriorly, bowed backwards posteriorly, weakly convex longitudinally. Terrace lines about sixteen in number, most of which are continuous from side to side.

Hypostome rounded in posterior outline. Middle body evenly convex; crescentic posterior lobe slightly depressed, with small maculae laterally. Anterior wings large, broadly pointed, sloping dorsally upwards; continuous with narrow, swollen posterior border. Surface smooth, except for anterior wings which bear longitudinal terrace lines, widely spaced.

Pygidium gently convex proximal to doublure, sloping steeply downwards laterally. Anterior margin almost transverse. Axis indistinguishable except for slight forward convexity and depressions at positions of axial furrows, half width of pygidium, or more, apart. Doublure two-sevenths length of pygidium, weakly convex, with a faint longitudinal median depression; anterior margin simple except for a minute median cusp, distinguishable only on well-preserved specimens. Surface smooth; terrace lines on doublure closely spaced, faint.

*Remarks.* The pygidium of *B. scoticus* differs from the type species, *B. milleri* (Billings) (see Whittington 1954, pp. 138-9, pl. 62, figs. 16-18, 20, 25, 26, 29), in the almost

transverse anterior outline and in the monocuspid, not bicuspid, anterior margin of the doublure. The doublure is monocuspid also in *B. billingsi* (Raymond and Narraway) (see Bradley 1930, pl. 28, fig. 2), but the doublure is longer in that species.

Family HARPIDAE Hawle and Corda 1847  
Genus HIBBERTIA Jones and Woodward 1898

*Hibbertia whittingtoni* sp. nov.

Plate 81, figs. 1-3

*Diagnosis.* Eye tubercles forwardly placed. Brim widest antero-laterally, forepart flexed upwards. Pits fine, radially arranged on cheek roll. Short genal caeca proximally on brim.

*Holotype.* A. 5862a, b (cephalon). Plate 81, figs. 1a-c.

*Other material.* Four cephalons and fragments of brim.

*Dimensions of holotype* (in mm.).

Length of cephalon (sag.)	5.0
Length of cephalon (exs.)	7.7
Width of cephalon . . .	8.9
Width of cheek roll . . .	4.4
Length of glabella . . .	1.9

*Description.* Width of cephalon approximately equal to length, but variable; glabella moderately long, narrowing forwards, swollen. Basal lateral lobes well developed. Occipital ring short; occipital furrow shallow. Alae small, depressed. Eye tubercles large, forwardly placed, strongly raised. Eye ridges indistinct. Preglabellar field extends less than half distance to brim. Cheek roll convex, strongly rounded in outline antero-laterally. Posterior borders raised, weakly defined. Border strong, extending to tip of brim. Brim widest antero-laterally, gently concave except for prolongations; forepart of brim anterior to cheek roll flexed upwards. Brim prolongation shorter than median length of cephalon, narrowing steadily, upwardly inclined. Cheek roll prolongation narrows slowly at first, extending to tip of brim prolongation. Outer rim moderately developed on both lamellae.

Glabella punctate medianly. Alae smooth. Pits on cheek roll and brim small, radially arranged on cheek roll; short genal caeca proximally on brim, either one or two pits between caeca. Outer rim smooth.

*Remarks.* This species is referred to *Hibbertia* rather than *Selenoharpes* because the girder extends to the tip of the cheek prolongation; shape and pitting of the glabella, and flexure of brim are other features of resemblance. The occurrence of genal caeca on the inner part of the brim, and the fineness of the pitting of the brim are characters of *Selenoharpes*, which serve to distinguish this from other species of *Hibbertia*.

Family OTARIONIDAE Richter and Richter 1926  
Genus OTARION Zenker 1833

*Otarion* sp.

*Material.* One incomplete cranium.

*Remarks.* The distinctive feature of this specimen is the weak convexity of the glabella and of the large basal lobes.

Family DIMEROPYGIDAE Hupé 1953

Genus DIMEROPYGE Öpik 1937

*Dimeropyge hystrix* sp. nov.

Plate 81, figs. 4-10

*Diagnosis.* Glabella strongly swollen; margin of anterior border angled mesially; palpebral lobes situated anterior to mid-length of glabella; posterior borders with a pair of swellings proximally and several small tubercles laterally.

*Holotype.* A. 5865a, b (cranium). Plate 81, figs. 4a-c.

*Paratypes.* A. 5869 (free cheek); A. 5871a, b (pygidium).

*Other material.* Seventeen cranidia, six free cheeks, two pygidia.

*Dimensions* (in mm.).

	<i>Holotype</i> A. 5867a, b	
Length of cranium . . . . .	3.0	3.0
Length of glabella . . . . .	2.0	1.9
Width of glabella (maximum) . . . . .	1.6	1.7

*Description.* Glabella narrowly ovate, strongly convex in both directions, standing well above cheeks, sloping forwards and downwards. Muscle areas absent. Preglabellar and axial furrows continuous and deep; axial furrows wide at back. Occipital ring convex longitudinally, moderately arched transversely. Occipital furrow broad and shallow. Preglabellar field moderately long, continuous with cheeks, steeply inclined, convex, with a shallow longitudinal median depression. Fixed cheeks broad, convex, highest near back. Palpebral lobes small, elevated, situated anterior to mid-length of glabella and twice their own length from posterior border; one- and two-thirds maximum width of glabella apart. Palpebral furrows well defined. Margin of anterior border angled mesially, convex, almost as long as preglabellar field. Anterior border furrow broad and shallow. Posterior borders short (exs.) proximally, increasing in length and inflation laterally. Anterior branches of facial sutures converge slightly forwards; posterior branches run obliquely outwards and backwards to posterior border furrows, thence curving more strongly outwards and cutting posterior margin immediately inside librigenal spines. Cranium set with aciculate tubercles directed upwards on glabella, backwards on occipital ring, and forwards on preglabellar field and on forefront of anterior border. Occipital ring more finely tuberculate than glabella, sometimes with three large tubercles placed towards back of ring. Fixed cheeks slightly more coarsely tuberculate than glabella; usually a single tubercle on median depression, with a pair of tubercles on either side, hind ones prominent. Posterior part of anterior border granular. Posterior borders with a pair of swellings proximally surmounted by one or more diminutive tubercles; lateral parts swollen, with several small tubercles; parts between low and smooth.

Eye small, strongly convex. Inner area of cheek broad, weakly convex. Lateral border set at an angle to inner area, narrow anteriorly, widest opposite posterior border furrow. Lateral border furrow moderately deep, curving inwards posteriorly to join posterior

border furrow. Libriginal spine moderately long, tapering steadily, curving strongly inwards near tip. Doublure narrow and produced anteriorly, as wide as free cheek opposite posterior border where a (concave) vincular swelling is developed, flattened under spines. Inner area of cheek coarsely tuberculate; border granular, with a marginal row of long slender tubercles; libriginal spine granular.

Pygidium short, flattened, with a deep, almost vertical, border. Axis broad anteriorly, narrowing strongly, composed of three segments. First ring well formed, moderately arched; second ring with transversely oval lateral areas more swollen than median part; third ring represented only by a pair of small, transversely oval swellings. Ring furrows shallow but continuous. Axial furrows shallow. Three pairs of narrow, slightly swollen pleurae; pleural furrows oblique, shallow. A pair of tubercles behind axis is the only indication of a fourth segment. Border deep, sloping steeply and uniformly downwards. Pygidium granular; a low tubercle placed proximally on each pleuron, a pair of aciculate tubercles, posterior much the larger, at extremities.

*Remarks.* In cephalic characters *D. hystrix* bears a close resemblance to *D. spinifera* Whittington and Evitt (1954, pp. 42-46, pl. 22; pl. 23; text-figs. 9, 10) from the Lincolnshire Limestone; the main points of similarity are the strongly swollen glabella, the shallow median depression crossing the preglabellar field, the incurved tips of the free cheeks, the aciculate tuberculation, and the arrangement of tubercles on the posterior borders. In pygidial characters the resemblance is less close.

*D. minuta* Öpik (1937, pp. 32-33, pl. 3, figs. 1, 2; pl. 4, fig. 5; pl. 12, figs. 1, 2; pl. 19, fig. 1) from the Kukruse Shales possesses even larger swellings than *D. hystrix* proximally on the posterior borders, but is quite distinct in other respects.

#### Genus TOERNQUISTIA Reed 1896

##### *Toernquistia* sp. A

Plate 81, figs. 11a, b

*Material.* Two cranidia.

*Description.* Glabella broadly rounded in outline anteriorly, convex; lateral glabellar furrows absent. Preglabellar and axial furrows continuous, deep and broad; median preglabellar pit large, indenting preglabellar field. Preglabellar field almost half length of glabella, convex, sloping steeply downwards. Anterior border moderately long, sloping forwards, border furrow well defined. Fixed cheeks moderately wide, gently convex. Shallow depressions run outwards and forwards from antero-lateral angles of glabella. Palpebral lobes large. Posterior borders widen (exs.) steadily laterally. Surface finely tuberculate.

*Remarks.* The cranidium figured bears some resemblance to the type species, *T. nicholsoni* (Reed 1896, pp. 433-5, pl. 21, figs. 3, 3a) but the glabella is much less swollen, and the divergent antero-lateral furrows are shallower.

##### *Toernquistia* sp. B

Plate 81, fig. 12

*Material.* One cranidium.

*Remarks.* This cranidium differs from the foregoing species in its shorter, more swollen glabella, and longer anterior border.



## Genus MESOTAPHRASPIS Whittington and Evitt 1954

*Mesotaphraspis* sp.

Plate 81, figs. 13, 14

*Material.* One cranium [two free cheeks].

*Description.* Cranium weakly convex in both directions. Glabella lanceolate in outline, weakly convex. Lateral lobes and furrows lacking. Preglabellar and axial furrows continuous, lightly impressed; shallow median furrow extends a short way across preglabellar field. Occipital ring moderately long; occipital furrow shallow, transverse. Preglabellar field approximately three-eighths length of glabella, weakly inclined, continuous with fixed cheeks. Palpebral lobes moderately long, weakly defined. Anterior border of uniform width.

[Free cheek narrow, weakly rounded in outline. Eye large; lens surface convex. Anterior branches of facial sutures diverge slightly forwards; posterior branches run outwards and then curve strongly backwards to cut posterior margin just inside genal angle. Inner area gently convex, at narrowest part slightly wider than border. Lateral border of uniform width, well defined. Librigenal spine continuous with lateral border in curvature, tapering strongly. Surface smooth.]

*Remarks.* This species resembles *M. inornata* Whittington and Evitt (1954, pp. 48–49, pl. 24, figs. 1–39) from the Lincolnshire Limestone more closely than it does *M. parva* Whittington and Evitt (1954, pp. 46–48, pl. 3, figs. 31–36; pl. 4, fig. 11) from the Edinburgh Limestone. The following are the main differences from *M. inornata*: (1) The glabella is narrower and more pointed anteriorly; (2) the lateral lobes and furrows are lacking; (3) the preglabellar furrow is much more shallow and the median pit is lacking. The free cheeks described agree better with *Mesotaphraspis* than with *Toernquistia* (see Warburg 1925, pl. 5, fig. 41).

## Family RAPHIOPHORIDAE Angelin 1854

## Genus AMPYX Dalman 1827

*Ampyx* sp.

Plate 81, figs. 22, 23

*Material.* One cranium, one pygidium.

*Description.* Cranium convex in both directions, but distorted. Glabella swollen, widening steadily forwards; anterior part narrowing rapidly and projecting beyond cephalic margin. Anterior spine broken off at base, rounded in cross-section. First pair of lateral muscle areas faintly defined. Lateral glabellar areas not developed. Preglabellar and axial furrows shallow. Occipital ring convex, curved weakly backwards in outline, continuous with posterior borders, which slope steeply forwards laterally. Fixed cheeks wide (tr.) and sloping steeply downwards anteriorly, connected in front of glabella; anterior border flexed forwards.

Pygidium elliptical in outline, weakly convex. Axis about one-quarter anterior width, narrowing rapidly at first, then slowly, weakly defined. Inner parts of pleural lobes flattened; border slopes gently outwards, narrow (exs.), slightly embayed mesially.

One pair of faint pleural furrows, concave forwards; area anterior to furrows depressed. Surface smooth, except for shallow terrace lines closely spaced on border.

*Remarks.* The cranium resembles the type species *A. nasutus* Dalman (see Whittington 1950, pp. 554-6, pl. 74, figs. 3-9; text-figs. 6a, b) and also *A. camurus* Raymond (see Cooper 1953, p. 16, pl. 5, figs. 1-2, 6-7) in shape of glabella and absence of lateral glabellar areas. The pygidium is much shorter than in either of these species.

### Genus LONCHODOMAS Angelin 1854

#### *Lonchodomas pernix* sp. nov.

Plate 82, figs. 1-7

*Diagnosis.* Glabella narrow, tapering slowly anteriorly, carina absent. Posterior borders curve slightly forwards; posterior border furrows sharp. Basal part of glabella pitted.

*Holotype.* A. 5885a, b (cranium). Plate 82, figs. 1a-d.

*Paratypes.* A. 5887 (free cheek); A. 5890 (pygidium).

*Other material.* Sixteen cranidia, two free cheeks, one hypostome, fourteen pygidia.

*Dimensions of holotype* (in mm.).

Length of cranium to base of spine	. 8.9
Width of cranium	. . . 9.3
Maximum width of glabella	. . . 3.7
Basal width of glabella	. . . 2.0

*Description.* Length of cranium great compared with width, but variable. Glabella narrow, tapering slowly anteriorly, moderately convex longitudinally, strongly arched particularly at back. Hindmost part of glabella swollen to form a transverse ridge. Frontal spine square in cross-section, straight, horizontally extended; upper pair of angular ridges converge for a short distance on glabella but do not meet; carina absent. Axial furrows broad and shallow, not crossing occipital segment; elongate fossulae just posterior to greatest width of glabella. Occipital ring bowed gently backwards, sloping forwards and downwards, continuous with posterior borders. Posterior borders become narrower laterally, and curve slightly forwards. Posterior border furrows sharp; lateral pits near extremities. Fixed cheeks narrow, convex, sloping forwards. Courses of facial sutures gently sinuous. Faint, longitudinal raised lines on antero-lateral slopes of glabella near base of frontal spine. Cranium shallowly but irregularly pitted. Basal part of glabella strongly pitted; smooth, triangular, basal muscle areas strongly developed, other muscle areas indistinct.

Free cheek narrow, sloping steeply outwards; inner area convex. Librigenal spine long and slender, rectangular in cross-section, horizontally extended, curving gently inwards. Doublure of cheeks continuous beneath glabella, longest (sag.) mesially, where doublure gently convex, narrowing laterally. Distal band flattened. Proximal band abruptly depressed, becoming wider and increasingly convex towards median line; outline of inner margin rounded, with a slight median embayment. Surface of cheek and doublure smooth.

Hypostome trapeziform in outline, weakly convex longitudinally, strongly arched transversely. Middle body broadly rounded in posterior outline. Posterior lobe and

maculae not developed. Border narrow, convex, thickened and bent down at posterior wings. Posterior border furrow shallow.

Thorax with axis three-eighths total width, weakly arched. Articulating half ring faint; articulating furrow deep and broad. Axial furrows shallow. Inner parts of pleurae wide (tr.), directed straight outwards, and horizontally extended. Pleural furrows transverse, placed at two-thirds length from front, widening laterally. Outer parts of pleurae bent vertically downwards, incomplete.

Pygidium subtriangular. Axis broad, ill defined, arched transversely, extending a short distance onto border. Axial furrows indistinct. Inner parts of pleural lobes weakly convex; border gently convex, sloping steeply downwards, wide (exs.) laterally, embayed mesially. One pair of pleural furrows, concave forwards, sharply defined laterally; area anterior to furrows depressed. Terrace lines closely spaced on border. Remainder of surface smooth.

*Remarks.* Professor H. B. Whittington has pointed out that the name *L. tumidum* (Tripp 1962, p. 15) is a secondary homonym of *A. tumidus* Forbes (1849, pl. 10, p. 4). I hereby propose *minuntionensis* as a substitute name. *L. pernix* differs from *L. minuntionensis* in its weaker longitudinal convexity and in the shape of the glabella. It is distinguished from most other species by the absence of carina and by the slowly tapering anterior part of the glabella.

Family CHEIRURIDAE Salter 1864  
Genus CERAURINELLA Cooper 1953

*Ceraurinella* sp.

Plate 82, fig. 8

*Material.* One cranidium.

*Material from other horizons.* Cranidia from the *superstes* Mudstones, Aldons.

*Remarks.* The affinities of this cranidium are with *Ceraurinella* from which it differs in the weak definition and sinuous course of the axial furrows, and the absence of tuberculation on both glabella and cheeks.

Genus SPHAEREXOCHUS Beyrich 1845

*Sphaerexochus* sp.

Plate 82, figs. 10-17

*Material.* Twelve cranidia, two free cheeks, five pygidia.

*Material from other horizons.* All parts from the *superstes* Mudstones, Aldons.

*Description.* Glabella variable in proportions, frequently much wider than long, sloping steeply downwards with strong convexity. Basal lateral glabellar furrows deepest near anterior inner angles, proximal parts almost longitudinal, shallow. Palpebral lobes placed opposite basal lateral furrows. Fixed cheeks with genal angles bluntly pointed in large specimens (Pl. 82, fig. 12), produced into short spines in smaller specimens (Pl. 82, fig. 11*b*); lateral and posterior margins sigmoidal in outline.

Inner area of free cheek and lateral border narrow; vincular notch strongly developed, lateral border furrow shallow and narrow compared with other species.

Pygidium twice as wide as long. Axis narrow. Third ring fused with terminal piece and with third pleurae. Axial furrows shallow anteriorly, moderately deep and very broad alongside terminal piece, interrupted opposite third ring. Three pairs of short, narrow, swollen pleurae, extending successively further backwards. Free points long, narrow, bluntly pointed, or rounded, with broad, rounded notches between.

Dorsal surface and doublure granular, pygidium more densely so than remainder of exoskeleton.

*Remarks.* This species differs from *S. euryis* Tripp (1962, pp. 19–20, pl. 3, figs. 1–7) in that successive pygidial pleurae extend further backwards. Cranidia are extremely variable and hard to distinguish reliably.

### Genus SPHAEROCORYPHE Angelin 1854

#### *Sphaerocoryphe* sp.

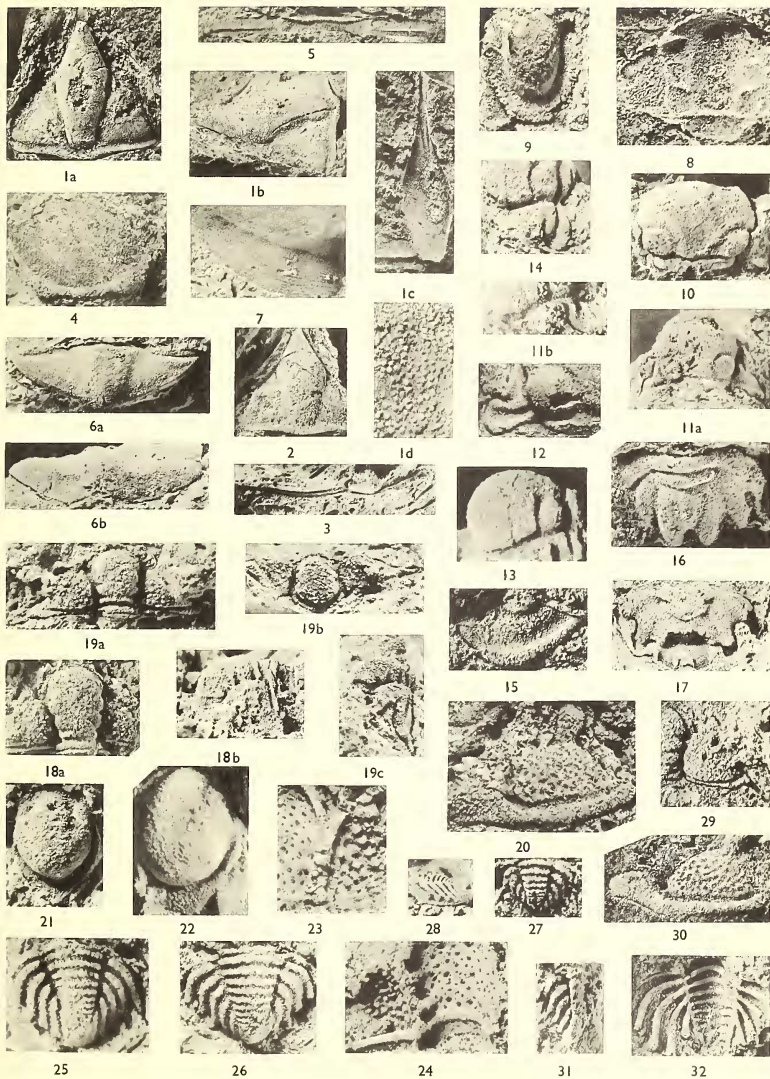
Plate 82, fig. 9

*Material.* One cranium, one hypostome, one fragmentary pygidium.

*Remarks.* Cranium small (1.6 mm. in length) with elongate bulbous glabellar lobe. Hypostome subrectangular, with elongate middle body. The anterior pair of pygidial pleurae end in comparatively long, outwardly directed free points. The species is too inadequately known for close comparison.

#### EXPLANATION OF PLATE 82

- Figs. 1–7. *Lonchodomas pernix* sp. nov. 1a, b, Cranium (holotype, A. 5885a). Dorsal and oblique lateral views,  $\times 3$ . 1c, The same, external mould (A. 5885b),  $\times 3$ . 1d, Enlargement of external mould of basal part of glabella to show pitted surface with smooth areas,  $\times 12$ . 2, Short cranium (A. 5886),  $\times 3$ . 3, Right free cheek (A. 5887), showing doublure and dorsal surface at base of librifugal spine,  $\times 6$ . 4, Posterior part of hypostome (A. 5888),  $\times 10$ . 5, Thoracic segment (A. 5889b), external mould,  $\times 4$ . 6a, b, Pygidium (A. 5890). Dorsal and posterior views,  $\times 5$ . 7, Pygidium (A. 5891). External mould showing anastomosing terrace lines on border,  $\times 8$ .
- Fig. 8. *Cerawrinella* sp. Cranium (A. 5892). External mould,  $\times 6$ .
- Fig. 9. *Sphaerocoryphe* sp. Hypostome (A. 5893),  $\times 8$ .
- Figs. 10–17. *Sphaerexochus* sp. 10, Cranium with broad glabella (A. 5894a),  $\times 4$ . 11a, Small cranium with narrow glabella (A. 5895a). Dorsal view,  $\times 6$ . 11b, The same. Lateral view, showing short fixigenal spine,  $\times 8$ . 12, Large cranium (A. 5896) devoid of fixigenal spines,  $\times 4$ . 13, Cranium (A. 5897a). Lateral view,  $\times 12$ . 14, Cranium (A. 5898a). Lateral view showing diminutive fixigenal spine,  $\times 5$ . 15, Right free cheek (A. 5899a),  $\times 6$ . 16, Pygidium (A. 5900b). Latex mould from external cast,  $\times 5$ . 17, Pygidium (A. 5901). Specimen with rounded pleurae and notches,  $\times 4$ .
- Figs. 18–28. *Encrinuroides obesus* sp. nov. 18a, b, Cranium (holotype, A. 5902a). Dorsal and lateral views,  $\times 4$ . 19a–c, Small cranium (A. 5903a). Dorsal, frontal, and lateral views. Note tall palpebral lobe in lateral view,  $\times 8$ . 20, Left free cheek (A. 5904a),  $\times 8$ . 21, Hypostome (A. 5905),  $\times 8$ . 22, Hypostome (A. 5906). Latex mould from external mould showing granulation of surface and pits on anterior part of middle body,  $\times 10$ . 23, Cranium (A. 5907). External mould, showing unpitted eye ridges, bordered by large pits,  $\times 12$ . 24, Cranium (A. 5908b). External mould, showing three pairs of sizable tubercles on glabella,  $\times 12$ . 25, Pygidium (A. 5909a),  $\times 10$ . 26, Pygidium (A. 5910a). Comparatively broad axis emphasized by slightly anterior view,  $\times 8$ . 27, Small pygidium (A. 5911a),  $\times 12$ . 28, Pygidium (A. 5912a). Lateral view showing steep doublure,  $\times 6$ .
- Figs. 29–31. *Encrinuroides* sp. 29, Cranium (A. 5913). Left fixed cheek is closely associated,  $\times 6$ . 30, Left free cheek (A. 5914),  $\times 6$ . 31, Pygidium (A. 5915a), laterally compressed,  $\times 5$ .
- Fig. 32. *Encrinuridae* indet. Pygidium (A. 5916b). External mould,  $\times 6$ .







## Family ENCRINURIDAE Angelin 1854

## Genus ENCRINUROIDES Reed 1931

*Encrinuroides obesus* sp. nov.

Plate 82, figs. 18-28

*Diagnosis.* Glabella slightly wider anteriorly than posteriorly, inflated; frontal lobe strongly rounded in outline. Eyes backwardly placed. Fixiginal spines slender. Tuberculation weak. Pygidium short, with broad axis, and six pairs of short pleural ribs.

*Holotype.* A. 5902a, b (cranium). Plate 82, figs. 18a, b.

*Paratypes.* A. 5904a, b (free cheek); A. 5905 (hypostome); A. 5909a, b (pygidium).

*Other material.* Twenty-two cranidia, eighteen free cheeks, five hypostomes, ten pygidia.

*Dimensions of holotype* (in mm.).

Length of cranium . . . . .	4.4
Width of cranium (estimated) . . . . .	9.6
Length of glabella . . . . .	3.5
Width of glabella across frontal lobe . . . . .	2.9
Width of glabella across basal lobes . . . . .	2.0

*Description.* Cephalon elliptical in outline, strongly convex in both directions. Glabella pyriform, narrowing little towards back, rising high above cheeks, strongly convex in both directions. Frontal lobe almost half length of glabella, strongly rounded anteriorly; longitudinal median furrow shallow, extending backward from preglabellar furrow for one-fifth length of glabella. Posterior lobe short, marked off by posterior lateral furrows which are faintly connected across central lobe; anterior and middle lateral lobes faintly defined by short furrows on steep lateral slopes of glabella, middle lobes slightly longer than anterior. Occipital ring short, strongly arched transversely. Occipital furrow shallow, transverse. Axial furrows deep and narrow; apodemes proximally at points of junction with middle and posterior lateral and occipital furrows; deep fossulae at forefront. False preglabellar field flattened, short. Preglabellar furrow deep and broad. Fixed cheeks convex, sloping inwards proximally. Positions of eye ridges indicated by absence of pitting. Palpebral lobes small, elevated, situated opposite hind part of middle lateral lobes, near mid-width of cheeks. Posterior borders short (exsag.), depressed, directed straight outwards. Posterior border furrows narrow. Laterally posterior borders widen slightly, and join short lateral borders; fixiginal spines slender, moderately long, directed outwards and more or less strongly backwards. Anterior branches of facial sutures run obliquely forwards and inwards from eyes, cutting axial furrows immediately anterior to fossulae and meeting in front of false preglabellar field; posterior branches curve outwards and slightly backwards.

Eye lobe elongatedly oval, moderately high; lens surface convex, half height of lobe, marked off by a shallow furrow on internal moulds. Inner area of free cheek weakly convex, almost three times width of border. Pseudoglabellar area and anterior border fused, continuing curve of lateral border. Lateral border convex, weakly rounded in outline. Lateral border furrow deep and broad, slightly stronger anteriorly than posteriorly. Doublure convex, as wide as border.

Hypostome subtriangular, anterior outline strongly rounded. Middle body oval, strongly swollen; longitudinal median lobe short, widening rapidly backwards. Maculae

indistinct. Anterior border moderately broad, flexed upwards. Anterior wings slope dorsally upwards. Lateral borders horizontally extended, widening slowly backwards. Posterior tongue pointed, comparatively short. Surface granular; parts of middle body shallowly pitted.

Pygidium triangular, strongly convex, composed of twelve or more axial rings and six pairs of pleurae. Axis occupies about half maximum width of pygidium, convex longitudinally, with comparatively long post-axial ridge. Ring furrows continuous but faint mesially at back. Axial furrows straight, strongly convergent, becoming faint posteriorly. Pleural lobes narrow, sloping gently outwards with weak convexity. Successive pleural ribs directed increasingly backward; first four pairs of pleurae end in short, out-turned free points; fifth pair subparallel, sixth pair indistinctly marked off from axis, hardly reaching margin. Inter-pleural furrows broad, moderately deep. Articulating facets weakly developed. Doublure narrow, sloping steeply downwards.

Cephalon within borders, including pseudoglabellar area, sparsely covered by comparatively small tubercles of various sizes; a pair of conspicuous tubercles placed between basal lateral lobes. Inner areas of cheeks closely pitted, fixed cheeks more strongly so than free cheeks. Palpebral lobes and occipital ring smooth; posterior borders with a few small tubercles. Pseudoglabellar areas of free cheeks finely tuberculate; anterior and lateral borders granular, devoid of tubercles. Surface of pygidium granular; a few large granules on axial rings. Doublure finely granular.

*Remarks.* The squat pygidium, with broad axis, distinguishes *E. obesus* from all described species except *E. fallax* (Reed 1899, pp. 753-5, pl. 49, figs. 9-12) from the Tramore Limestone, which it closely resembles in many respects. The main differences are that the eye lobes are situated further apart and further back, the tuberculation is weaker, the pygidium is more strongly convex, and the sixth pair of pleurae are less developed in *E. obesus*.

*Encrinuroides* sp.

Plate 82, figs. 29-31

*Material.* One cranium, two free cheeks, four pygidia.

*Description.* Glabella weakly convex, rising no higher than cheeks. Basal lateral lobes exceptionally short; lateral furrows short and broad. Palpebral lobes situated near mid-width of cheeks, not quite as far back as in *E. obesus*. Fixigenal spines comparatively long and stout, curving outwards and backwards.

Free cheek gently convex; eye stalk incomplete. Inner area broad. Pseudoglabellar area and anterior border fused, set at an angle to lateral border, which narrows towards back. Lateral border furrow becomes weaker posteriorly. Surface of inner area sparsely tuberculate and shallowly pitted; pseudoglabellar area and lateral border granular.

Pygidium narrow, strongly vaulted. Axis narrow compared with pleurae, convex longitudinally, composed of about fourteen rings. Six pairs of pleurae, last pair short; first four pleurae end in long horizontally extended free points. Pleural ribs narrow, strongly swollen, rib furrows broad. Surface smooth except for a few low tubercles on axial rings.

*Remarks.* This species differs conspicuously from *E. obesus* in the less convex glabella, the outline of the free cheek, and narrow, vaulted pygidium.

## Genus CYBELE Lovén 1846

*Cybele* ? sp.

Plate 83, fig. 1

*Material.* One incomplete cranium.

*Description.* Glabella unknown except for swollen middle and posterior lateral lobes, standing higher than fixed cheek. Fixed cheek broad, weakly convex. Palpebral lobe elevated, placed far forwards. Eye ridge almost transverse, moderately long (tr.). Posterior border short (exs.), furrow broad, flat bottomed, bordered on anterior side by a raised ridge. Surface granular. Inner area of cheek except for eye ridge and posterior ridge shallowly and closely pitted. Entire inner area of cheek very sparsely tuberculate.

*Remarks.* The unpitted ridge at the back of the inner area of the fixed cheek is an unusual feature, which occurs also in *Cybele bellatula* Dalman (see Öpik 1937, pp. 120-1, text-fig. 34), a species in which the eye ridges are similarly developed. The specimen is not sufficiently complete to justify an unqualified determination.

## Genus QUINQUECOSTA gen. nov.

*Diagnosis.* Glabella widens steadily forwards, strongly convex. Frontal lobe at least half length of glabella. Three pairs of lateral glabellar lobes; posterior pair much the smallest with lateral nodes; anterior lateral glabellar furrows bifurcate, anterior branches short. Anterior border short, swollen laterally, dying out mesially. Eyes moderately large, placed opposite middle lateral furrows and close to glabella. Pygidium composed of about twelve axial rings and five pairs of backwardly directed pleural ribs which terminate bluntly on the arc of a circle.

*Type species.* *Q. williamsi* sp. nov.

*Remarks.* *Quinquecosta* is most closely related to certain members of the Subfamily Cybelinae; *Atractopyge xiphères* (Öpik 1925, pp. 11, 12; pl. 1, figs. 10, 11; 1937, p. 121, pl. 7, fig. 3; pl. 21, figs. 3, 4), for instance, presents a comparable bifurcation of the anterior lateral glabellar furrows, and the free cheeks are similarly constructed. The five pairs of pygidial ribs (unfurrowed pleurae) distinguish *Quinquecosta* from *Cybele*, which has five pairs of furrowed pleurae, and from *Atractopyge*, which has four pairs of pleurae or ribs. Pygidia of *E. quinquecostatus* Männil 1958 and *E. pilisiverensis* Rosenstein 1941 possess only five pairs of ribs, but the new genus is quite different in the longer, less divergent ribs, quadrate rather than triangular outline, and absence of axial tubercles.

Certain features are evocative of the family Phacopidae—for instance, the glabella widening steadily forwards; long frontal lobe; apodemes on middle and posterior, not the anterior, lateral furrows; short posterior lateral glabellar lobes, with lateral nodes. The general stamp of the cranium, and the five pairs of long pygidial ribs suggest a pliomnerid relationship, and as such this form was recorded in Williams's monograph (1962, p. 47).

*Quinquecosta williamsi* gen. et sp. nov.

Plate 83, figs. 2-10

*Diagnosis.* Glabella as long as wide. Lateral lobes wide; middle lateral lobes almost as large as anterior pair. Occipital ring long, as wide as base of glabella.

*Holotype*. A. 5918a, b (cranium). Plate 83, figs. 2a, b.

*Paratypes*. A. 5920 (free cheek); A. 5923a, b (hypostome); A. 5924 (pygidium).

*Other material*. Twenty-five cranidia, forty-five free cheeks, seven hypostomes, twenty-nine pygidia.

*Material from other horizons*. Cranidia, hypostomes, and pygidia from the *superstes* Mudstones, Aldons.

*Dimensions of holotype* (in mm.)

Length of cranium . . . . .	6.5
Width of cranium . . . . .	14.5
Length of glabella . . . . .	5.5
Width of glabella across frontal lobe . . . . .	6.1
Width of glabella across basal lobes . . . . .	3.4

*Description*. Glabella subpentagonal in outline, evenly convex in both directions. Frontal lobe half length of glabella (sag.); a shallow median pit near mid-length; antero-lateral angles sharply rounded. Lateral glabellar lobes wide, with some independent convexity but continuous with central lobe; anterior pair narrower proximally than distally; posterior pair much the shortest, expanding laterally. Anterior lateral furrows bifurcate within short distance; anterior branches short, convergent forwards, posterior branches long, transverse, shallow. Middle lateral furrows short and deep, converging forwards. Posterior lateral furrows directed inwards and backwards for a short distance, then bending forwards. Occipital ring moderately long (sag.) and convex, as wide as basal lobes; occipital tubercle centrally placed, low. Occipital furrow shallow, bowed forwards. Transversely elongate apodemes at distal extremities of middle and posterior lateral furrows; rounded apodemes at extremities of occipital furrow. Axial furrows narrow, much deeper than lateral furrows; deep, rounded fossulae opposite anterior border furrow. Anterior border extremely short, well defined and swollen laterally,

#### EXPLANATION OF PLATE 83

- Fig. 1. *Cybele* ? sp. Cranium (A. 5917), showing ridge running alongside posterior border furrow,  $\times 4$ .
- Figs. 2-10. *Quinquecosta williamsi* gen. et sp. nov. 2a, b, Cranium (holotype, A. 5918a). Dorsal and oblique lateral views,  $\times 3.75$ . 3, Cranium (A. 5919b). External mould,  $\times 8$ . 4, Right free cheek (A. 5920),  $\times 4$ . 5, Right free cheek (A. 5921). External mould,  $\times 6$ . 6, Cranium and reversed thoracic segment (A. 5922a). Oblique lateral view,  $\times 2.5$ . 7, Hypostome (A. 5923a),  $\times 8$ . 8a, b, Pygidium (A. 5924). Dorsal and lateral views; axis extends almost as far as posterior margin,  $\times 3.5$ . 9a-c, Pygidium (A. 5925). Latex cast from external mould. Dorsal, postero-ventral, and oblique lateral views; note short axis and post-axial ridge,  $\times 4$ . 10, Small pygidium (A. 5926b). Latex cast from external mould; note short axis and incurved pleurae,  $\times 6$ .
- Fig. 11. Encrinuridae indet. Right free cheek (A. 5927b). External mould,  $\times 5$ .
- Figs. 12-16. *Amphilichas priscus* sp. nov. 12a, Cranium (holotype, A. 5928b). Latex cast from external mould. Dorsal view,  $\times 4$ . 12b, c, The same. Lateral and frontal views,  $\times 3$ . 13, Small cranium (A. 5929),  $\times 10$ . 14a, Hypostome (A. 5930a), attributed to this species,  $\times 5$ . 14b, The same, external mould (A. 5930b),  $\times 10$ . 15, Pygidium (A. 5931a), attributed to this species,  $\times 6$ . 16, Pygidium (A. 5932), attributed to this species. External mould,  $\times 12$ .
- Figs. 17-19. *Amphilichas* sp. 17, Cranium (A. 5933a). Lateral view,  $\times 3$ . 18, Hypostome (A. 5934) attributed to this species,  $\times 3$ . 19, Pygidium (A. 5935b) attributed to this species. External mould,  $\times 8$ .
- Fig. 20. *Hemiarges* sp. Cranium (A. 5936a),  $\times 10$ .
- Fig. 21. *Ceratocephala* sp. Cranium (A. 5937). External mould,  $\times 10$ .



